

## **SINGLE-LAYER INTERCHANGE OVERPASS**

### **[0001] Technical field**

[0002] The invention relates to an overpass, and especially an interchange overpass suitable for city roads and highways.

### **[0003] Background**

[0004] In order to solve traffic jams at city intersections many types of overpasses have been employed. Generally, triple level and higher grade overpass intersections are built for channeling motor and non-motor vehicles and for enabling transfer without impact and interference. Such high grade overpasses with their extra long ramps inconvenience drivers and occupy too much space. Especially in cities where much repositioning has to be done, the compensation cost for relocation of residents may be high. Providing clover-type overpasses will cause traffic jams in case of increased vehicle flow due to entanglement between the turning vehicles and the circling vehicles.

### **[0005] Summary of the invention**

[0006] The invention provides a single-level interchange overpass having simple construction and full functionality, and occupying less space.

[0007] The technical solution of the invention is as follows: a single-level interchange overpass according to this invention comprises a main road and an intersected road, wherein a U-shaped circle road is provided on the horizontal level at both ends of the main road, a inner semicircle road and a outer semicircle road are provided at an exit of the said U-shaped circle road, a common road is provided between the inner semicircle road and the outer semicircle road, the common road is connected to an on-ramp of the intersected road through the outer semicircle road, and an off-ramp of the intersected road is connected to the

on-ramp of the main road through the inner semicircle road.

[0008] In the above-described technical solution, an arched separated bridge is provided on the main road of the single layer interchange overpass, semi-ramped overhead bridge stages are provided on the intersected road on both sides of the arched separated bridge, the said semi-ramped overhead bridges stages are connected with the arched separated bridge through a connection platform, U-shaped circle roads are provided on the horizontal level at both ends of the arched separated bridge, the arcuate end of the outer semicircle road and the inner semicircle road is connected to the U-shaped circle road, the other end of the outer semicircle road and inner semicircle road of the U-shaped circle road is connected to the connection platform, a branch common road is provided on the off-ramp of the arched separated bridge of the main road, the other end of the common road is connected to the connection platform, a right turn road is provided at the entrance of the upper and lower U-shaped circle roads, and the other end of the right turn road is connected to the on-ramp of the arched separated bridge.

[0009] In the technical solution of this invention, in the single layer interchange overpass, the main road can be a leveled driveway, and the intersected road can be an overhead bridge, the U-shaped circle road comprises the inner semicircle road and the outer semicircle road, the common road is connected with the entrance of the outer semicircle road of the U-shaped circle road on other side of the overhead bridge after passing through under the overhead bridge, and the inner semicircle road is connected to the on-ramp of the main road through the left turn driveway .

[0010] The effects of the invention are as follows:

[0011] Reduction of the traditional 3 or 4 layer overpass to a single layer overpass allowing for transfer of vehicles from different directions and for separation of the motor and non-motor vehicles without inference. Pedestrians

can walk on the original road eliminating the need to pass through tunnels or pedestrian overpasses. Reduction of the number of layers in the structures leads to an economic benefit.

[0012] The ramp of the overpass is slow which provides significant advantages of energy saving, noise reduction and wasteful exhaust reduction.

[0013] The compact construction occupies less space, producing high efficiency ramps, while low height of the construction facilities reduction in costs, environmental protection, and improved aesthetic sense.

#### **[0014] Description of the drawings**

[0015] **Fig. 1** is a plan view and directional scheme of one embodiment of the invention;

[0016] **Fig. 2** is a cross-sectional view along the line A-A of **Fig. 1**;

[0017] **Fig. 3** is a plan view and directional scheme of another embodiment of the invention;

[0018] **Fig. 4** is a plan view and directional scheme of yet another embodiment of the invention.

[0019] In the **Figs:** **1** - main road, **2** - arched separated bridge, **3** - intersected road, **4** - inner semi-circular road, **5** - outer semi-circular road, **6** - underpass tunnel, **7** - common road, **8** - semi-ramped overhead bridge, **9** - right on-ramp, **11** - bidirectional median, **12** - non-motor vehicle road, **13** - secondary road, **14** - left turning circle road, **17** - convergent secondary road, **18** - U-shaped circle road entrance, **19** - ventilating window, **23** - connection platform, **24** - U-shaped circle road, **25** - arcuate end, **26** - U-turn median, **27** - straight transition road, **28** - U-turn road, **29** - overhead bridge, **30** - left turn branch lane, **31** - right turn branch lane, **32** - right turn road, **33** - outer pass way.

#### **[0020] Detailed Description**

[0021] Conventional circle-type intersections are associated with traffic jams caused by the entanglement and interference between vehicles making turns and vehicles circling on the overpasses. In order to solve this problem, in the overpass of the invention an outer semicircle road **5** and an inner semicircle road **4** are provided on the U-shaped circle road **24** on the upper side of the main road **1** to channel the turning vehicles and the straight-going vehicles. At the same time a common road **7** is provided between the outer semicircle road **5** and the inner semicircle road **4** to prevent the vehicles on the U-shaped circle road **24** from interfering.

[0022] The invention will now be described in detail in accordance with the drawings. In the embodiments the terms “left ”and “right ”refer to the travel direction of the vehicles, and the terms “upper” “lower” “left ”and “right” refer to the orientation of the overpasses. With the overpass forming a base for an off-ramp and an on-ramp, the road entering the overpass is the off-ramp and the road exiting the overpass is the on-ramp.

[0023] Example 1

[0024] As shown is **Fig. 1**, an overpass is provided at an intersection. The intersection is divided into the upper, lower, left, and right roads in which the main road **1** accommodates vehicle flow in the upper and lower direction, and the intersected road **3** accommodates vehicle flow in the left and right direction. The four roads of the overpass are leveled with the driveway's surface and are connected therewith. The straight main road **1** on the overpass is the arched separated bridge **2** which has the highest height at a position where the main road **1** intersects the intersected road **3**. There is a ramp extending from the highest point of the arched separated bridge **2** down the upper and lower direction to connect it in the direction of the main road **1**. The semi-ramped overhead bridge stages **8** are provided at the left and the right of the intersected road **3** at both sides of the arched separated bridge **2**. One end of the semi-ramped overhead

bridge stage **8** is connected with the arched separated bridge **2** at the same level and forms a connection platform **23**, and the other end is connected with the driveway in left and right directions, i.e., in the direction of the intersected road **3**. The arched separated bridge **2** and the semi-ramped overhead bridge stage **8** are provided with bidirectional driveways having off-ramps and on-ramps. The U-shaped circle road **24** which is leveled with the connection platform **23** is provided at a height of the upper and lower direction ramps of the arched separated bridge **2**. The U-shaped circle road **24** comprises entrances **18** and exits connected with the left connection platform **23** and the right connection platform **23**, respectively, and also the arcuate end **25** between the entrance **18** and the exit. The exit comprise an inner semi-circle road **4** in proximity to the interior of the main road **1** and an outer semi-circle road **5** positioned on the outer side of the main road **1**. The arcuate end **25** of the U-shaped circle road **24** is higher with respect to the ramp of the arched separated bridge **2**. The other end of the entrance **18** and the exit of the U-shaped circle road **24** are connected with the connection platform **23** of the left and right semi-ramped overhead bridge stage **8**, respectively. A closed-circle road is formed after connecting the upper and lower U-shaped circle roads through the connection platform **23**. The shape of the circle road is similar to that of the racetrack in a stadium. The unidirectional driveway running anticlockwise is used in the above-referenced circle road.

[0025] On the inner side of the outer semicircle road **5** of the upper and lower U-shaped circle road **24**, i.e., between the arched bridges **2** and the outer semicircle road **5**, an inner semicircle road **4** is provided. One end of the inner semicircle road **4** is connected with the arcuate end **25** of the U-shaped circle road and the other end is connected with the connection platform **23** of the arched separated bridge **2**.

[0026] A branch common road **7** is provided as the off-ramp of the arched separated bridge **2** of the main road **1**. The above-referenced common road **7**

connects the road surface of the main road **1** with the connection platform **23** or the ramp of the arched separated bridge **2** after passing vertically under the accurate end **25** of the U-shaped circle road **24**. The connector of the common road **7** and the connection platform **23** is located between the connectors of the inner semicircle road **4** and the outer semicircle road **5** and the connection platform **23**, respectively. The inclusion of common road **7** effectively ensures the traveling of vehicles on the connection platform **23** and the U-shaped circle road **24** without interference.

[0027] The right on-ramp **9** is provided at the entrance **18** of the upper and lower U-shaped circle road **24** i.e. the right side of the upper U-shaped circle road **24** and the left side of the lower U-shaped circle road **24**. The other end of the right on-ramp **9** is connected with the on-ramp of the arched separated bridge **2**.

[0028] As shown in **Fig. 1**, due to the design of overhead arched separated bridge **2** and the semi-ramped overhead bridge stage **8**, the non-motor vehicle road **12** for bicycles and pedestrians is provided under the overpass. The non-inference with motor vehicles in the areas of the existing intersections fully satisfies the condition of transfer of the pedestrians and bicycles. Therefore the inconvenience that would be caused by construction of the underground passage way is eliminated. In order to improve the illumination under the overpass, ventilation windows **19** passing through the surface of the overpass are formed at the connection platform **23** of the overpass.

[0029] Below the traveling directions of the vehicles on the overpass are explained with reference to arrows indicating the traveling directions in **Fig. 1**. (1) Straight ahead from lower to upper side: vehicles pass over the overpass along the right entrance of the bidirectional driveway in the lower main road **1** through the arched separated bridge **2** straight ahead from the lower side under the arcuate part **25** of the U-shaped circle road **24** through to the on-ramp of the upper main road **1**. (2) Straight ahead from left to right: vehicles travel to the left connection

platform **23** after entering the left semi-ramped overhead bridge stage **8** from the on-ramp of the bidirectional driveway in the left intersected road **3**, and then enter the connection platform **23**, turn right entering the entrance **18** of the outer U-shaped circle road **24**, again enter the right connection platform **23** from outer semi-circle or road **5** of the lower U-shaped circle road **24** along the arcuate part **25** of the lower U-shaped circle road **24**; then turn right and travel across the overpass entering the right off-ramp of the intersected roads from the right semi-ramped over head bridge stage **8**, completing the straight way on the intersected roads via a zigzag manner instead of straight manner. (3) Turn from the lower main road **1** onto the right interested road **3**: vehicles enter the right common road **7** through the entrance of the bidirectional driveway along the lower main road **1**, and from the common road **7** enter the right connection platform **23**, and then turn right entering the right semi-ramped over head bridge stage **8** continuing onto the on-ramp of the right intersected road **3** and passing through the overpass. (4) Turn from the lower main road **1** onto the left intersected road **3**: vehicles enter the right common road **7** through the entrance of the bidirectional driveway along the lower main road **1**, and from the common road **7** enter the right connection platform **23**, and then continue straight up to the upper U-shaped circle road **24**, turning around into the left connection platform **23** along the upper outer semicircle road **5**, and then turn right entering the right semi-ramped over head bridge stage **8** continuing onto the on-ramp of the left intersected road **3** and passing through the overpass. (5) Turn from the left intersected road **3** into the lower main road **1**: after entering the semi-ramped overhead bridge stage **8** from the entrance of the bidirectional driveway in the left intersected road **3** vehicles enter the connection platform **23**, and then turn right into the lower U-shaped circle road **24**, enter the on-ramp of the lower main road of the right on-ramp **9** which is connected with the lower U-shaped circle road **24**, and so pass through the overpass. (6) Turn from the left intersected road **3** onto

the upper main road **1**: after entering the semi-ramped overhead bridge stage **8** through the entrance of the bidirectional driveway in the left intersected road **3** the vehicles enter the connection platform **23**, turn right into the lower U-shaped circle road **24**, and then enter the right connection platform **23** from the inner semi-circular road **4** of the lower U-shaped circle road **24** along the arcuate part **25** of the lower U-shaped circle road **24**, and enter the on-ramp of the upper arched separated bridge **2** by merging left on the right connection platform **23**, and then pass through the overpass from the on-ramp of the upper arched separated bridge **2** accomplishing the convergence into the main road without interference with the convergent secondary road **17**, and pass through the overpass from the on-ramp of the upper arched separated bridge **2**. (7) Return to the lower main road **1** from the lower main road **1**: The vehicles enter the right common road **7** along the entrance of the bidirectional driveway in the lower main road **1**, and enter the right connection platform **23** from the common road **7**, straightway to the upper U-shaped circle road **24**, then enter the left connection platform **23** passing around the inner semicircle road **4** of the upper U-shaped circle road **24** along the upper U-shaped circle road **24**, and then enter the left connection platform **23** into the on-ramp of the lower arched separated bridge **2** by merging left off of the left connection platform **23**, turning back to the on-ramp of the lower main road **1** from the on-ramp of the lower arched separated bridge **2**. (8) Return to the left intersected road **3** from the left intersected road **3**: after entering the semi-ramped overhead bridge stage **8** from the entrance of the bidirectional driveway in the left intersected road **3** the vehicles enter the connection platform **23** and turn right into the lower part of connection platform **23**, then turn around into the inner semi circle road **4** of the lower U-shaped circle road **24** along the lower U-shaped circle road **24**, and then enter the right connection platform **23**, and then enter the upper U-shaped circle road **24** by bearing right on the right connection platform **23**, then enter the left connection



platform **23** from the outer semi circle road **5** of the upper U-shaped circle road **24**, along the arcuate part **25** of the upper U-shaped circle road **24**, then turn right to enter the right on-ramp of the left intersected road **3** from the left semi-ramped overhead bridge stage **8**, thus accomplishing the turnaround.

[0030] From the foregoing it is clear that that the height of the overpass of the invention is reduced compared with the typical multilayer overpass, and also the occupied ground area and ramp size have been reduced. Compared with the clover-like overpass there is no interference on the main roads which facilities turning of the vehicles on the overpass in left and right direction and turning back.

[0031] Because the overpass of the invention is of single layer, not including the ground, therefore the height from the ground is limited only by the U-shaped circle road and generally is about 5 meters of clearance.

[0032] In order to increase the driving safety, the double solid line or the bidirectional median **11** between the bidirectional driveways is used to separate the driveways in two directions. In the case of driving to the on-ramp of the arched separated bridge **2** from the inner semicircle road **4** through the connection platform **23**, a convergent secondary road **17** is provided at the right side of the on-ramp of the arched separated bridge **2** for avoiding accidents caused by the abrupt entering of vehicles.

[0033] In this embodiment, vehicles are assumed to drive on the right side of the road; for other countries or regions where vehicles travel on the left side of the road, arrangement of the driveways on the overpass can be changed accordingly, and this is also contemplated by the invention.

[0034] Example 2

[0035] The U-shaped circle road **24** is relatively long because the ramp length of the arched separated bridge **2** must satisfy the regulation of the ramp of the driveway and ensure clearance between the arcuate part **25** of the U-shaped circle

road **24** and the arched separated bridge **2**. As shown in **Fig. 2**, in order to shorten the length of the U-shaped circle road **24**, construction of the embodiment **1** is partially modified by allowing the height of the arcuate part **25** of the U-shaped circle road **24** to exceed the height of the connection platform **23**, so that the combination of the upper and lower U-shaped circle roads **24** has a saddle-like shape. Thus, in order to shorten the length of the U-shaped circle road **24**, vehicles will enter an up-ramp when traveling from the connection platform **23** onto the U-shaped circle road **24**, and will enter a down-ramp when traveling from the U-shaped circle road **24** onto the connection platform **23**.

[0036] Because vehicles enter an up-ramp after entering the entrance **18** of the U-shaped circle road **24**, the speed of the vehicles is automatically reduced and the margin for safely turning the vehicle on the arcuate end **25** increased.

[0037] If there is no need to provide non-motor vehicle and pedestrian ways under the overpass then the arched separated bridge **2** can be constructed as a flat driveway, and accordingly the connection platform **23** can be provided on the ground, thereby avoiding the need for vehicles to enter the connection platform **23** and the ramp of the arched separated bridge **2**. Raising the arcuate part **25** of the U-shaped circle road **24** to a certain height will ensure that the vehicles on the main road **1** pass under the arcuate part **25** of the U-shaped circle road thus allowing for a large reduction in the overall height of the overpass.

[0038] Example 3

[0039] As shown in **Fig. 3** in order to reduce the driving distance of vehicles turning around on the intersected road **3** in embodiments 1 and 2, medians **26** for turning around are provided on the left and right connection platforms **23**, respectively. The median **26** for turning around separates the connection platform **23** into the straight transit driveway **27** between the upper and lower U-shaped circle roads **24** and the U-turn driveway **28**, which not only ensures a straight-way driving between the upper and lower U-shaped circle roads **24**, but

also allows vehicles turning around on the intersected road **3** to enter the on-ramp through the U-turn driveway **28** directly after entering the connection platform **23** from the off-ramp, thus decreasing the turnaround distance on the U-shaped circle road **24**.

[0040] If the topographic condition permits or if there is a need to expand capacity, an underpass tunnel **6** in the direction of the left and right intersected road **3** can be added beneath the walking way surface extending through the main road **1**. By doing so, the straight-driving vehicle from left to right or vice versa don't need to travel around the connection platform **23** and the U-shaped circle road **24**, and as a result vehicles can be driven faster and more conveniently, to meet the larger traffic flow. If there is no need to consider the pedestrian and non-motor vehicle ways under the overpass, such as in the highways and suburbs, then the underpass tunnel **6** can be constructed as a semi-sinking underpass tunnel passing the arched separated bridge **2** resulting in a reduction of construction costs and improvement in ventilation and in water-removal from the tunnel. Alternatively, it is also possible to provide the overhead bridge passing through the upper side of the connection platform **23** and the arched separated bridge **2** between the left and right intersected roads **3**. Therefore the vehicles on the intersected road **3** can travel straight-through, thus enabling the overpass to be constructed by several periods and added with one more layer of single span bridge to form another main road.

[0041] Example 4

[0042] As shown in **Fig. 4**, the overpass of the embodiment is suitable for use in highways and expressways. A level driveway is provided between the upper and lower sides of the main road **1** while at both sides of the main road **1** a secondary road **13** parallel with the main road **1** is provided. The outer pass way **33** connects the main road **1** and the secondary road **13**. The overhead bridge **29** passing above across the main road **1** is provided between the left and right sides of the

intersected road **3**.

[0043] The U-shaped circle roads **24** are provided at the horizontal level at both the upper and lower sides of the main road **1**. The U-shaped circle roads **24** include the inner semicircle roads **4** and the outer semi circle roads **5**. The branch common road **7** is provided on the secondary road **13** connected with the off-ramp of the main road **1**. The lower common road **7** is connected with the entrance of the outer semicircle road **5** of the upper U-shaped circle road **24** after passing through under the overhead bridge **29**, while the upper common road **7** is connected with the entrance of the outer semicircle road **5** of the lower U-shaped circle road **24** after passing through under the overhead bridge **29**. The outer semicircle road **5** is connected with the on-ramp of the overhead bridge **29** after passing across the arcuate end **25** of the main road. The left turn branch lane **30** is connected with the on-ramp of the inner semicircle road **4** from the off-ramp of the overhead bridge **29** on the intersected road **3** while the inner semi circle road **4** is connected with the on-ramp of the secondary road **13** through the left turn driveway **14** after passing across under the arcuate end **25** of the main road.

[0044] The right turn branch lane **31** is provided between the overhead bridge **29** and the secondary road **13** connected with the on-ramp of the main road. The right turn branch lane **31** is connected with the secondary road **13** through the lower ramp. The right turn road **32** is provided on the secondary road **13** connected with the off-ramp of the main road **1**. The right turn road **32** is connected with the on-ramp of the overhead bridge **29** through the upper ramp. The pavement and non-motor vehicle way **12** are provided on the outer side of the secondary road **13**.

[0045] Below the driving directions of the vehicles on the overpass will be described with connection to the arrows in **Fig. 4** indicating the driving direction of the vehicles. (1) Straight through from the lower side to the upper side: the vehicles travel straight-ahead to the upper part of the road along the lower part of

the main road **1**. (2) Straight through from the left to right: the vehicles travel straight to the right part of the road from the left part of the road of the overhead bridge **29** on the intersected road **3**. (3) Turn from the lower main road **1** onto the right intersected road **3**: the vehicles enter the secondary road **13** through the outer pass way **33** from the off-ramp of the main road **1**, and then from the right turn road **32** connected with the secondary road **13** turn right by the upper ramp entering the on-ramp of the overhead bridge **29** of the intersected road **3**. (4) Turn from the lower main road **1** onto the left intersected road **3**: the vehicles enter the secondary road **13** through the outer pass way **33** from the off-ramp of the main road **1**, and then from the common road **7** connected with the secondary road **13** enter the on-ramp of the U-shaped circle road **24** after passing under through the overhead bridge **29**, then after entering the outer semicircle road **5** through the arcuate end **25** enter the on-ramp of the overhead bridge **29**. (5) Turn from the left intersected road **3** onto the lower main road **1**: the vehicles enter the on-ramp of the main road via the lower ramp of the right turn branch lane **31** of the over head bridge **29**. (6) Turn from the left intersected road **3** onto the upper main road **1**: the vehicles enter from the off-ramp of the overhead bridge **29** on the intersected road **3** onto the on-ramp of the inner semicircle road **4** through the left turn branch lane **30**, and then enter the secondary road **13** after passing through the left turn road **14** by the lower ramp of the arcuate end **25**, then enter the on-ramp of the main road **1** through the outer pass way **33**.

[0046] Since the height of the overpass of the embodiment is the height of the overhead bridge **29** or the arcuate end **25** of the U-shaped circle road **24**, the overpass belongs to a single layer type. The transfer of the vehicles on the overpass will not cause any inference.

[0047] It should be noted that while the foregoing description is aimed to illustrate the principle of the invention, those skilled in the art will appreciate that certain variations and modifications of the basic embodiments are possible.

Therefore, the invention is not limited by any particular construction of the embodiments, and all of the modifications are within the scope of the invention.